

## REMARKS

Claims 1, 13, 14, 29, 36, and 42 have been amended. Accordingly, claims 1-6, 8-19, 21-47, and 49 are pending in the present application. The claim amendments and new claims are supported by the specification and claims as originally filed, with no new matter being added. In particular, support for the amendments and new claims can be found in the specification from page 8, line 21 to page 9, line 2 of the application as filed. Accordingly, favorable reconsideration of the pending claims is respectfully requested.

### 1. Non-Rejected Claims

Applicants note that claims 22, 44, and 45 have not been identified as rejected under any of the cited references. Applicants presume, therefore, that these claims contain allowable subject matter and respectfully request the prompt allowance of these claims.

### 2. Rejections Under 35 U.S.C. § 112

Claim 5 has been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which application regard as the invention. In particular, the Examiner has indicated that claim 5 should depend upon claim 3 instead of claim 4 in order to have proper antecedent basis.

In response, claim 5 has been amended to change the antecedent basis. Applicants therefore respectfully request that the rejection of claim 5 under 35 U.S.C. § 112 be withdrawn.

### 3. Rejections Under 35 U.S.C. §§ 102 and 103

Before addressing the Examiner's specific rejections, the Applicants believe it would be

helpful to cite the following portion of the present application that relates to a surprising and significant aspect of the invention, which Applicants respectfully submit the Examiner has not given adequate weight in examining the present claims:

Etch selectivity fluorocarbon gasses, intended herein to mean CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, C<sub>4</sub>F<sub>8</sub>, C<sub>5</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and the like and combinations of these, have been used in previous applications as etch gasses, *but not as a selectivity enhancing etch gas* for nitride or silicon compounds while etching oxides on semiconductive substrates. During development of the present invention, it was discovered that under the operating conditions set forth herein, increased etch selectivity fluorocarbon etch gas in addition to the hydrofluorocarbon etch gas such as CHF<sub>3</sub> etch gas, caused an increased etch selectivity for a nitride compound, or a silicon dioxide underlying layer doped differently from the silicon dioxide dielectric layer.

Specification, page 8, line 21 to page 9, line 2 (emphasis added).

Therefore, each of the independent claims 1, 13, 14, 29, 36, and 42 has been amended to clarify this aspect of the invention. For example, claim 13 now recites, “an etch [a] selectivity enhancing compound.” The other independent claims have been similarly amended.

Claims 1, 2, 6, 8, 9, and 13 have been rejected under 35 U.S.C. § 102(e) as being unpatentable over U.S. Patent No. 6,194,325 to Yang et al. (“*Yang ‘325*”) for the reasons set forth on pages 2-3 of the Office Action. Claims 3-5, 10-12, and 36-41 have been rejected under 35 U.S.C. § 103 as being unpatentable over *Yang ‘325* for the reasons set forth on pages 7-9 of the Office Action. Applicants respectfully traverse.

*Yang ‘325* states, “*the addition of one or more hydrogen-containing gasses, preferably one or more hydrofluorocarbon gasses, to one ore more fluorine-substituted hydrocarbon etch gasses and a scavenger for fluorine, in a plasma etch process . . . results in a high selectivity to oxide in preference to nitride.*” Column 2, lines 32-37 (emphasis added). This is exactly the opposite of what is recited in present claims 1, 13, and 36. Whereas *Yang ‘325* discusses the use of a *hydrogen-containing gas*

to increase selectivity, the present claims recite the use of gasses that do not include hydrogen (and which are well known *etch-enhancing* gasses) for selectivity enhancing. *See* claims 1, 13, and 36.

Accordingly, Applicants respectfully assert that claims 1, 13, and 36 contain limitations that are not disclosed, taught, or suggested by *Yang* '325 and that claims 1, 13, and 36 are therefore patentable over *Yang* '325. Claims 2-6, 8-12, and 37-41 depend from a respective one of claims 1 and 36, include the limitations therein, and are therefore patentable over *Yang* '325 for at least the reasons presented hereinabove with respect to claims 1 and 36.

Claims 1-3, 5, and 9 have been rejected under 35 U.S.C. § 102(b) as being unpatentable over U.S. Patent No. 5,269,879 to Rhoades et al. ("*Rhoades*") for the reasons set forth on page 3 of the Office Action. Claims 4, 8, 10-12, and 36-38 have been rejected under 35 U.S.C. § 103 as being unpatentable over *Rhoades* for the reasons set forth on pages 9-11 of the Office Action. Applicants respectfully traverse.

*Rhoades* relates to the use of one or more fluorocarbon or hydrofluorocarbon gasses as an etch gas. The disclosed gas formulations are used to etch silicon oxide and *silicon nitride* while suppressing sputtering of metal. *Rhoades*, column 3, lines 4-6 and 50-52. However, nowhere does *Rhoades* disclose the use of the presently recited materials as an etch selectively enhancing gas.

Accordingly, Applicants respectfully assert that claims 1 and 36 contain limitations that are not disclosed, taught, or suggested by Rhoades and that claims 1 and 36 are therefore patentable over Rhoades. Claims 2-5, 8-12, and 37-38 depend from a respective one of claims 1 and 36, include the limitations therein, and are therefore patentable over Rhoades for at least the reasons presented hereinabove with respect to claims 1 and 36.

Claims 1, 2, 6, 9, 14-16, 19, 42, 43, and 46 have been rejected under 35 U.S.C. § 102(e) as being unpatentable over U.S. Patent No. 6,227,211 to Yang et al. ("*Yang* '211") for the reasons set

forth on pages 3-4 of the Office Action. Claims 4, 8, 21, 23-30, 32, 33, 35, 47, and 49 have been rejected under 35 U.S.C. § 103 as being unpatentable over *Yang* '211 for the reasons set forth on pages 11-14 of the Office Action. Applicants respectfully traverse.

*Yang* '211 relates to the use of a specific three-stage etch with a specific etch stop layer to obtain a desired bottom profile for etched holes. As with others of the cited references, *Yang* '211 also discloses the use of both hydrofluorocarbons and fluorocarbons in a system to obtain a desired selectivity, but, as with the other references, *Yang* '211 also fails to teach or suggest the use of the presently recited gasses and compounds, which are traditional etch gasses, as the etch selectivity enhancing gasses.

Additionally, *Yang* '211 does not disclose, teach, or suggest “stopping the second etching upon the etch stop layer,” as recited in present claim 14. Rather, the methods of *Yang* '211 do not stop an etch upon the etch stops as evidenced by *Yang* '211’s disclosure that the etch stops are not at the bottom of the etched hole and in fact merely serve to slow down the etch. See *Yang* '211 at column 2, lines 37-43.

Accordingly, Applicants respectfully assert that claims 1, 14, 29 and 42 contain limitations that are not disclosed, taught, or suggested by *Yang* '211 and that claims 1, 14, 29 and 42 are therefore patentable over *Yang* '211. Claims 2, 4-6, 8, 9, 15, 16, 19, 21, 23-30, 32, 33, 35, 43, 46, 47, and 49 depend from one of claims 1, 14, 29 and 42, include the limitations therein, and are therefore patentable over *Yang* '211 for at least the reasons presented hereinabove with respect to claims 1, 14, 29 and 42.

Claims 1, 2, 6, and 9 have been rejected under 35 U.S.C. § 102(b) as being unpatentable over U.S. Patent No. 5,880,006 to Lin et al. (“*Lin*”) for the reasons set forth on page 4 of the Office Action. Claims 4, 8, 10-12, 36, and 39-41 have been rejected under 35 U.S.C. § 103(a) as being

unpatentable over *Lin* for the reasons set forth on pages 21-23 of the Office Action. Applicants respectfully traverse.

As with others of the cited references, *Lin* discloses the use of both hydrofluorocarbons and fluorocarbons (“CHF<sub>3</sub> and/or CF<sub>4</sub>, together with Ar”) in a system to obtain a desired selectivity, but, also as with the references, *Lin* fails to teach or suggest the use of the presently recited etch selectivity enhancing gasses and compounds. *See Lin* at column 4, lines 13-18.

Accordingly, Applicants respectfully assert that claims 1 and 36 contain limitations that are not disclosed, taught, or suggested by *Lin* and that claims 1 and 36 are therefore patentable over *Lin*. Claims 2, 4, 6, 8-12, and 39-41 depend from one of claims 1 and 36, include the limitations therein, and are therefore patentable over *Lin* for at least the reasons presented hereinabove with respect to claims 1 and 36.

Claims 1, 2, 6, 9, and 14-19 have been rejected under 35 U.S.C. § 102(b) as being unpatentable over U.S. Patent No. 5,562,801 to Nulty et al. (“*Nulty*”) for the reasons set forth on pages 4-5 of the Office Action. Claims 3-5, 8, 10-13, 21, and 23-41 have been rejected under 35 U.S.C. § 103 as being unpatentable over *Nulty* for the reasons set forth on pages 14-16 of the Office Action. Applicants respectfully traverse.

In contrast to the presently recited claims, *Nulty* clearly states that *Nulty* relies upon a hydrofluorocarbon gas (C<sub>2</sub>H<sub>2</sub>F<sub>4</sub> (Freon 134a)) to achieve oxide/nitride etch selectivity, and not a fluorocarbon compound. *See Nulty* at column 9, lines 48-52; column 10, lines 21-26 (“mixtures of CHF<sub>3</sub> and C<sub>2</sub>F<sub>6</sub> do not exhibit the improved selectivity of Freon 134a, so that it appears the second hydrogen atom on the first carbon atom may be important to the proposed mechanism.”).

Accordingly, *Nulty* does not disclose, teach, or suggest an etch selectivity enhancing fluorocarbon compound,” as recited in claim 1, or the other etch selectivity enhancing gasses recited in claims 13, 14, 29, and 36.

Additionally, in contrast to claims 14 and 29, each of which recites a second etch recipe having a hydrofluorocarbon and a fluorocarbon, *Nulty* has no such disclosure. As indicated on page 4 of the Office Action, *Nulty* discloses a second etch that employs a plasma comprised of, e.g., CHF<sub>3</sub> – C<sub>2</sub>H<sub>2</sub>F<sub>4</sub>, neither of which is one of the presently recited fluorocarbons.

Accordingly, Applicants respectfully assert that claims 1, 13, 14, 29, and 36 contain limitations that are not disclosed, taught, or suggested by *Nulty* and that claims 1, 13, 14, 29, and 36 are therefore patentable over *Nulty*. Claims 2-6, 8-12, 15-19, 21, 23-28, 30-35, and 37-41 depend from one of claims 1, 14, 29, and 36, include the limitations therein, and are therefore patentable over *Nulty* for at least the reasons presented hereinabove with respect to claims 1, 13, 14, 29, and 36.

Claims 1, 2, 6, 9, 14-16, 19, 26, and 29 have been rejected under 35 U.S.C. § 102(e) as being unpatentable over U.S. Patent No. 6,133,153 to Marquez et al. (“*Marquez*”) for the reasons set forth on page 5 of the Office Action. Claims 4, 8, 21, 23-25, 29, 32, 33, 35, 42, and 43 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over *Marquez* for the reasons set forth on page 17-19 of the Office Action. Applicants respectfully traverse.

*Marquez* expressly teaches away from the presently recited claims in several ways. First, similarly to what is known in the art, *Marquez* teaches the use of CF<sub>4</sub> to increase the etch rate of etch processes. See *Marquez* at column 4, lines 11-13 and 25-30. Nowhere does *Marquez* teach that CF<sub>4</sub> increases selectivity. Additionally, in contrast to the presently recited claims, *Marquez* also teaches that it is a hydrofluorocarbon, CH<sub>2</sub>F<sub>2</sub>, that increases etch selectivity. Column 7, line 62 to column 8, line 1 (“It is believed that the increased flows of CH<sub>2</sub>F<sub>2</sub> gas advantageously enhances the selectivity

of the oxide to the nitride and the substrate.”).

Accordingly, Applicants respectfully assert that claims 1, 14, 29, and 42 contain limitations that are not disclosed, taught, or suggested by *Nulty* and that claims 1, 14, 29, and 42 are therefore patentable over *Nulty*. Claims 2, 4, 6, 8, 9, 15, 16, 19, 21, 23-26, 32, 33, 35, and 43 depend from one of claims 1, 14, 29, and 42, include the limitations therein, and are therefore patentable over *Nulty* for at least the reasons presented hereinabove with respect to claims 1, 14, 29, and 42.

Claims 1-3 and 9 have been rejected under 35 U.S.C. § 102(e) as being unpatentable over U.S. Patent No. 6,063,709 to Kuo et al. (“*Kuo*”) for the reasons set forth on page 6 of the Office Action. Claims 4, 5, 8, 11, 12, and 36-38 have been rejected under 35 U.S.C. § 103 as being unpatentable over *Kuo* for the reasons set forth on pages 19-21 of the Office Action. Applicants respectfully traverse.

As with others of the cited references, *Kuo* discloses the use of both hydrofluorocarbons and fluorocarbons (CHF<sub>3</sub>, CF<sub>4</sub>, and an inert gas such as Argon) in an etch process. However, as with the other cited references, *Kuo* also fails to teach or suggest the use of the presently recited gasses as etch selectivity enhancing gasses.

Accordingly, Applicants respectfully assert that claims 1 and 36 contain limitations that are not disclosed, taught, or suggested by *Kuo* and that claims 1 and 36 are therefore patentable over *Kuo*. Claims 2-5, 8, 9, 11, 12, 37, and 38 depend from one of claims 1 and 36, include the limitations therein, and are therefore patentable over *Kuo* for at least the reasons presented hereinabove with respect to claims 1 and 36.

Claims 1, 2, 6, 9, and 13 have been rejected under 35 U.S.C. § 102(b) as being unpatentable over U.S. Patent No. 5,286,344 to Blalock et al. (“*Blalock*”) for the reasons set forth on page 6 of the Office Action. Applicants respectfully traverse.

As with *Marquez*, *Blalock* also fails to disclose the use of the presently recited fluorocarbons to increase etch selectivity, teaching instead that it is a hydrofluorocarbon, *e.g.* CH<sub>2</sub>F<sub>2</sub>, that increases etch selectivity. *See Blalock* at column 4, lines 24-37.

Accordingly, Applicants respectfully assert that claims 1 and 13 contain limitations that are not disclosed, taught, or suggested by *Blalock* and that claims 1 and 13 are therefore patentable over *Blalock*. Claims 2, 6, and 9 depend from claims 1, include the limitations therein, and are therefore patentable over *Blalock* for at least the reasons presented hereinabove with respect to claim 1.

## CONCLUSION

In view of the foregoing, Applicants respectfully request favorable reconsideration and allowance of the present claims. In the event the Examiner finds any remaining impediment to the prompt allowance of this application which could be clarified by a telephone interview, the Examiner is respectfully requested to contact the undersigned attorney.

Dated this 16th day of December 2002.

Respectfully submitted,



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**VERSION WITH MARKINGS TO SHOW THE CHANGES MADE**

**In the Claims:**

Claims 1, 5, 13, 14, 29, 36, and 42 have been amended as follows:

1. (Once Amended) A method of removing silicon dioxide upon an etch stop layer, the method comprising:
  - providing a silicon dioxide dielectric layer upon an etch stop layer;
  - providing a gaseous etchant including a hydrofluorocarbon etch gas and including [a fluorocarbon] an etch selectivity enhancing fluorocarbon compound; and
  - exposing the silicon dioxide dielectric layer to the gaseous etchant.
5. (Once Amended) A method as defined in claim 3 [4], wherein the refractory metal nitride is selected from the group consisting of cobalt nitride, titanium nitride, tungsten nitride, and hafnium nitride.
13. (Once Amended) A method of etching a self-aligned contact comprising:
  - providing a semiconductive substrate having a silicon nitride layer thereon and a silicon dioxide dielectric layer on the silicon nitride layer;
  - placing the semiconductive substrate in an etch chamber;
  - etching into the silicon dioxide dielectric layer to form a depression, using gaseous CHF<sub>3</sub> and an etch [a] selectivity enhancing compound selected from the group consisting of CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, C<sub>4</sub>F<sub>8</sub>, C<sub>5</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and combinations thereof;
  - etching the depression to the semiconductive substrate; and
  - stopping said etching after the etch exposes the silicon nitride layer.
14. (Once Amended) A method of removing silicon dioxide dielectric upon an etch stop layer that is situated upon a semiconductive substrate positioned within an etch chamber, the method comprising:
  - etching the silicon dioxide dielectric to a first depth with a first etch recipe including a hydrofluorocarbon, the first etch recipe having a first selectivity to the etch stop layer;
  - etching the silicon dioxide dielectric to a second depth with a second etch recipe including the hydrofluorocarbon and an etch [a] selectivity enhancing compound consisting of a fluorocarbon selected from the group consisting of CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, C<sub>4</sub>F<sub>8</sub>, C<sub>5</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and combinations thereof, the second etch recipe having a second selectivity to the etch stop layer, wherein the first selectivity is greater than the second selectivity; and
  - stopping the second etching upon the etch stop layer.

29. (Once Amended) An etching method comprising:  
providing an etch chamber and a semiconductive substrate having thereon a bulk dielectric upon an underlying layer that is a compositionally dissimilar dielectric;  
etching the bulk dielectric with a first etch recipe including hydrofluorocarbon and an etch [a] selectivity enhancing gas consisting of fluorocarbon in a first proportion; and  
etching the bulk dielectric with a second etch recipe including hydrofluorocarbon and the etch selectivity enhancing gas in a second proportion that is greater than the first proportion, wherein etch selectivity to the underlying layer is greater for the second etch recipe than etch selectivity for the first etch recipe.

36. (Once Amended) In an etch chamber having a roof composed of silicon, a semiconductive substrate support for supporting a semiconductive substrate having a bulk dielectric disposed upon an etch stop layer, and having a silicon ring surrounding the semiconductive substrate support, an etching method comprising:

maintaining the temperature of:

the roof of the etch chamber in a range from about 135° C to about 200° C;  
the semiconductive substrate support in a range from about -30° C to about 80° C; and

the silicon ring in a range from about 180° C to about 250° C;

etching a recess having an aspect ratio of at least 5:1 in the bulk dielectric using a gaseous etchant including CHF<sub>3</sub> and an etch [a] selectivity enhancing compound consisting of carbon and fluorine;

etching the recess to the semiconductive substrate; and

stopping etching the recess after the etch stop layer has been exposed.

42. (Once Amended) A method of determining a specific etch recipe for etching silicon dioxide with predetermined selectivity to an etch stop layer underlying the silicon dioxide, the method comprising:

etching silicon dioxide with a gaseous etchant including a hydrofluorocarbon and an etch [a] selectivity enhancing gas consisting of carbon and fluorine to obtain a selectivity to the etch stop layer;

repeating said etching with different amounts of said etch selectivity enhancing gas consisting of carbon and fluorine to correspondingly obtain different selectivities to said etch stop layer;

selecting an amount of said different amounts of said etch selectivity enhancing gas [compound] corresponding to a desired etch selectivity to said etch stop layer; and

etching silicon dioxide with a gaseous etchant including the hydrofluorocarbon and said selected amount of said selectivity gas to obtain said desired selectivity to the etch stop layer.